Electric Motors and Generators

Look at a loop of wire in a magnetic field.

If you spin the wire, it induces an emf and a current - it is a generator.

$Emf=-N\Delta\Phi/\Delta t = -NBA/t$

If you apply an external emf, there is a current in the wires, therefore they will experience a force, $F_B=BIL$ - an electric motor

The force causes the wire to spin. While spinning, it acts like a generator, inducing a back emf opposing the applied emf.

$V_{back} = emf - Ir$

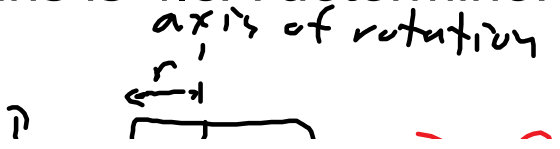
Back emf is proportional to the frequency of revolution

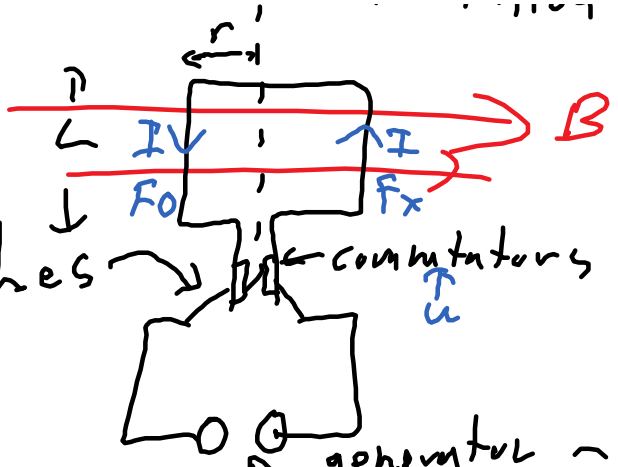
r is the resistance of the armature(wire part) of the motor

emf is the applied emf and I is the current through the motor.

Eg.

For the following motor, with 80 square loops of wire with length 1.50 cm in a 0.17T magnetic field. If the applied voltage is 6.0V and current when the armature is held is 8.5A and the current when the armature spins is 4.5A determine:





- sliding contacts
- contacts
- AC vs DC - types
- generator - output
- motor - applied emf - Power Supply

a) Torque of the motor – when spinning
b) Resistance of the armature
c) Back emf
d) Back emf if the frequency of rotation is halved.
e) Bonus: The rotation frequency at full rotation.

a) $\tau = Fr$

$\tau = 2NBIlr = NBAI$

↑ 2 wire every loop

$\tau = 60 \times 0.17T \times (0.015m)^2 (4.5A$

$= \boxed{0.014 Nm}$ 0.71Ω

b) $r = \frac{Emf}{I} = \frac{6.0V}{8.5A} =$

$\tau = 0.014\,Nm$ 0.71Ω

b) $r = \frac{\mathcal{E}_{mf}}{I} = \frac{6.0V}{8.5A} =$ Rnot spinning

c) $V_{back} = \mathcal{E}_{mf} - Ir$ 0.71Ω

$= 6.0V - 4.5A$

$= 2.8V$

d) if f is half, V_{back} is half $= 1.4V$

$\mathcal{E}_{mf_{Peak}} = 2\pi f NBA$

$\mathcal{E}_{mf} \propto f$

$\Phi = BA\cos\theta$

$\theta = 2\pi f t$